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Comparison of DRC-1339 and alpha-chloralose to reduce herring gull populations

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Abstract Results of several herring gull (*Larus argentatus*) control programs using DRC-1339 (3-chloro-4-methyl-benzenamine hydrochloride) suggested that the published median lethal dose (LD_{50}) of 2.9 mg of DRC-1339/kg of body weight may not be accurate in some environments. We conducted laboratory trials to estimate LD_{50} values of DRC-1339 and of alpha-chloralose (AC) for herring gulls inhabiting fresh water. We also conducted field trials to compare effectiveness of these compounds in simulated gull control operations. We calculated the LD_{50} for DRC-1339 as 4.6 mg/kg and 43.1 mg/kg for AC. Mean (±SD) time to death for DRC-1339-dosed birds varied from 34.0 (± 12.2) hours at LD_{96} to 109.5 (±55.5) hours at LD_{27}. AC time to death varied from 2.3 (±0.5) hours at $>LD_{99}$ to 5.8 (±0.0) hours at LD_{13}. In field trials, DRC-1339 baits treated at 27.4 mg/kg (LD_{99}) resulted in 29% known mortality. In contrast, AC baits with a 30-mg/kg dosage ($<LD_{01}$) resulted in 50% capture success and no mortality. AC baits at 58 mg/kg (LD_{99}) resulted in 89% capture success and 41% mortality. With AC baits at 95 mg/kg ($>LD_{99}$), 65% of gulls were captured with 82% mortality. AC was more effective than DRC-1339 in removing gulls from a nesting colony. We recommend consideration of AC as a gull population management chemical because it is fast-acting, humane, and can be used as a nonlethal capture agent.

Key words alpha-chloralose, capture agent, DRC-1339, herring gull, *Larus argentatus,* toxicant

An increase in gull (*Larus* sp.) populations in the United States has resulted in conflicts between gulls and people in urban, agricultural, and airport settings (Belant 1997). Gulls also threaten endangered species (e.g., roseate tern [*Sterna dougallii*]) by their adaptive and aggressive behavior at nesting colonies (Kress 1983, Blodget and Henze 1992). When gulls threaten human safety or endangered species, lethal gull control is often used (Blodget and Henze 1992, Dolbeer et al. 1993). Lethal control methods may include shooting, poisoning, or capturing and euthanizing (Solman 1994).

The only toxicant currently registered by the United States Environmental Protection Agency (EPA) to use on gulls is DRC-1339 (3-chloro-4-methyl-benzenamine hydrochloride). DRC-1339 may be used only by trained United States Department of Agriculture (USDA) personnel on coastal nesting colonies of herring (*L. argentatus*), ring-billed (*L. delawarensis*), and great black-backed (*L. marinus*) gulls. Schafer (1979) reported that the herring gull dosage required to kill 50% of the population (LD_{50}) for DRC-1339 was 2.9 mg/kg. However, Drennan et al. (1987) and Woronecki et al. (1989) collected data that suggested the LD_{50} was greater. Data reported by Schafer (1979) and Drennan et al. (1987) were collected from herring gulls inhabiting saltwater environments, whereas data gathered by Woronecki et al. (1989) were from herring gulls inhabiting a fresh-

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water environment. The general mode of action of DRC-1339 is to cause renal failure. Because the renal system functions differently between animals in freshwater and saltwater environments (Romer 1970, Shoemaker 1972), the LD_{50} of DRC-1339 for gulls in these 2 habitats may differ.

DRC-1339 is a slow-acting toxicant that may take up to several days to kill gulls (Woronecki et al. 1989, Blodget and Henze 1992). This delayed death may cause adverse public reaction (Tighe 1996) and is considered inhumane by the Humane Society of the United States (Hadidian et al. 1997).

Alpha-chloralose (AC) has been used as a sedative for animals (Balis and Monroe 1964) and is registered with the United States Food and Drug Administration (FDA) as a capture agent for waterfowl, coots, and pigeons (Woronecki and Thomas 1995). AC has been registered and used effectively for years in Great Britain, France, New Zealand, and Australia as an avian (including gulls) toxicant (Woronecki et al. 1989). The general mode of action of AC on birds is similar whether it is used as a capture agent or as a toxicant. AC rapidly depresses the corticol areas of the brain and is converted to trichloroethanol, which depresses the central nervous system, thus causing respiratory depression and abnormally low blood pressure (Lees 1972). The difference between lethal and capture levels of AC is the depth of depression of the central nervous system (Lees 1972). In addition, heart failure can occur in lethal doses (Borg 1955).

Our objectives were to 1) determine the LD_{50} of DRC-1339 and AC for herring gulls in a freshwater environment, and 2) compare the characteristics and effectiveness of DRC-1339 and AC as gull management chemicals. Procedures involving gulls were approved (Protocol Q.A. 74) by the National Wildlife Research Center Animal Care and Use Committee.

Methods

Pen trials

In May 1996, we captured herring gulls at a nesting colony documented by Dolbeer et al. (1990) in Sandusky Bay, Ohio, Lake Erie, using walk-in traps (Weaver and Kadlec 1970); transported them 10 km to the USDA field station in Erie County, Ohio; and held them in $2.5 \times 2.5 \times 2.0$-m shaded cages. A maximum of 7 gulls/cage were provided water and whole rainbow smelt (*Osmerus mordax*) *ad libitum*. We held birds $\geq$48 hours before testing. Birds that survived testing were released on site.

We tested 56 gulls/chemical, 7 gulls at each of 8 dosage levels, in May 1996. We based AC doses on quarter-log intervals that were established for waterfowl and included the most effective dose (30 mg/kg) for waterfowl (Woronecki et al. 1992). The doses used were 15, 24, 30, 37, 47, 58, 72, and 90 mg/kg. The 8 DRC-1339 doses, based on the published LD_{50} of 2.9 mg/kg (Schafer 1979), were 0.4, 0.8, 1.5, 2.9, 5.8, 10.6, 21.2, and 42.4 mg/kg. We calculated dosages (mg/kg) according to bird weight and toxicant concentrations. We mixed corn oil with either AC or DRC-1339 and inserted the mix into the bird's esophagus via a syringe and latex tube. After dosing, we placed gulls outdoors in shaded holding pens for observation. We estimated lethal doses and their 95% confidence levels using probit analysis (Stokes et al. 1995). Probit analysis uses death or survival responses (i.e., tolerances) assumed to follow a normal distribution. Probability of death at certain levels is based on the cumulative distribution of the data, the mean of the tolerance observed, and the standard deviation of the tolerances.

Field trials

We conducted field trials in May 1996 at the same herring gull nesting colony where gulls had been captured for pen trials. The estimated nesting population was 1,757 pairs (R.A. Dolbeer, United States Department of Agriculture, unpublished data). We selected 80 2- or 3-egg-clutch nests based on visibility from the water and marked them by painting a number on rocks adjacent to the nest. The 80 nests were maximally separated into 4 equal groups to avoid confusion among the 3 AC and 1 DRC-1339 treatments. We treated each nest with a single AC or DRC-1339 bread bait to assure a 1 bait/bird dose.

We conducted 3 AC trials at different nests over 2 days with 1 dose used per trial. We conducted 3 trials to document bait acceptance of various AC amounts and bird reaction to AC while on active nests. Minimum time between trials was 4 hours. Based on mean weights (0.95 kg) of previously captured birds, we treated bread baits with AC to yield doses of 30 ($<LD_{01}$), 58 (LD_{99}), and 95 ($>LD_{99}$) mg/kg. AC was mixed with corn oil and injected into bread baits (Woronecki et al. 1992) just prior to treatment. In each trial we selected 20 marked nests to receive 1 bait. The colony was observed for 1.5–2 hours after baiting to allow treated birds to become sedated and then searched to remove uneaten baits and affected birds. Baits not consumed within 30 minutes of placement were generally rejected by gulls because the bread dried out and was not palatable. Birds found alive but unconscious or conscious and exhibiting signs of AC sedation (e.g., inability to walk or keep their head up, uncoordinated flying) were considered to have eaten AC-treated bait. We conducted further searches of the colony and area within 2 km of the colony for 4 hours after bait placement.

Four days after the AC trials, we mixed DRC-1339 with corn oil, injected it into bread baits at the target dose of 27.4 mg/kg (LD_{99}), and placed the baits in the remaining 20 marked nests. Only 1 trial was conducted to confirm pen test results and to compare results with AC under similar conditions. We checked all nests 30 minutes after placing DRC-1339 baits and removed any remaining baits. This was done because, as with AC bread baits, DRC-1339 bread baits dried out after being exposed for 30 minutes and gulls generally reject these dried baits. Also, because DRC-1339 is a slow-acting toxicant, with birds showing no effects for at least 24 hours, we were not concerned about disturbing affected birds. We searched the colony and area within 2 km of the colony for affected gulls for 4 consecutive days following treatment. Birds found dead in or adjacent to treated nests were assumed to have died from DRC-1339. We necropsied birds found dead away from marked nests, and if kidneys appeared mottled or lighter than normal or if white deposits (uric acid) were found in the pericardium or peritoneum, the gulls were considered poisoned by DRC-1339 (DeCino et al. 1966).

Results

Pen trials

The LD_{50} for herring gulls treated with AC was 43.1 (95% confidence limits 38.0 – 48.6) mg/kg (Table 1). The LD_{50} for DRC-1339 was 4.6 mg/kg (3.0 – 7.2 mg/kg).

Mean (±SD) time to death varied in the AC trial from 2.3 (±0.5) to 5.8 (±0.0) hours and in the DRC-1339 trial from 34.0 (±12.2) to 109.5 (±55.5) hours (Table 2). Ten of the 27 AC birds that died exhibited tremors (e.g., wing flapping and head bobbing). One surviving DRC-1339 bird showed signs of physical discomfort (i.e., limping).

Field trials

Percentage of baits eaten was similar in all AC trials (X^2_2=2.29, P=0.30; Table 3). Also, there was no difference in percentage of baits eaten between DRC-1339 and AC trials (X^2_1= 2.89, P=0.09).

Table 1. Calculated doses (mg of chemical/kg of body mass) of alpha-chloralose and DRC-1339 resulting in death to various percentages of population for herring gulls (n=7/dose level), Erie County, Ohio, May 1996.

	Dosage (mg/kg)					
	Alpha-chloralose			DRC-1339		
LD		95% Confidence Level			95% Confidence Level	
(%)[a]	$\bar{x}$	Lower	Upper	$\bar{x}$	Lower	Upper
1	31.84	18.46	36.65	0.79	0.15	1.51
10	36.46	26.26	40.45	1.74	0.64	2.76
50	43.05	38.01	48.57	4.63	2.98	7.21
99	58.21	50.67	99.38	27.37	14.23	141.73

[a] Estimated percentage of population that died after receiving corresponding dose (mg/kg).

Sixteen of 20 baits with 30-mg/kg AC dosage (< LD_{01}) were eaten (Table 3). We captured 8 gulls and all recovered. Nineteen of 20 baits with 58-mg/kg dosage (LD_{99}) were eaten. We captured 17 gulls; 7 died and 10 recovered. Seventeen of 20 baits with 95-mg/kg dosage (> LD_{99}) were eaten. We captured 11 gulls; 9 died and 2 recovered. In summary, of 60 AC baits placed in nests, 52 were eaten and 36 gulls were captured. We found 27 of the captured gulls on or adjacent to their nest, with 16 dying.

Table 2. Dose levels (mg of chemical/kg of body weight) and time to death for captive herring gulls (n=7/dose level) treated with alpha-chloralose (AC) or DRC-1339, Erie County, Ohio, May 1996.

Chemical	Dose (mg/kg)	LD (%)[a]	Number dying	Time (hr) to death $\bar{x}$	SD
AC	15	<1	0	-	
	24	<1	0	-	
	30	<1	0	-	
	37	13	1	5.75	
	47	75	5	4.0	0.0
	58	99	7	3.0	0.5
	72	100	7	2.6	0.5
	90	100	7	2.3	0.5
DRC-1339	0.4	<1	0	-	
	0.8	1.2	0	-	
	1.5	8.5	0	-	
	2.9	27	2	109.5	55.5
	5.8	61	7	82.6	50.8
	10.6	85	4	50.3	4.3
	21.2	96	7	34.0	12.2
	42.4	100	7	40.6	12.1

[a] Estimated percentage of population that died after receiving corresponding dose (mg/kg).

Table 3. Number of herring gulls consuming baits treated with alpha-chloralose (AC) or DRC-1339 (*n*=20/dose) and percentage of gulls consuming baits that were captured and percentage of those captured that died during field trials, Erie County, Ohio, May 1996.

Chemical	Dose[a]	% of baits consumed	% of gulls consuming bait that were captured	% of captured gulls that died
AC	30	80	50	0
	58	95	89	41
	95	85	65	82
DRC-1339	27.4	70	29	100[b]

[a] mg of chemical/kg of body weight
[b] All DRC-1339 gulls were found dead in the field.

Fourteen of 20 DRC-1339 baits with 27.4-mg/kg dosage (LD_{99}) were eaten. We found 4 gulls that had died from DRC-1339 2–3 days after baiting. We found 2 birds at and 2 away from the colony.

Discussion

The LD_{50} value for DRC-1339 determined in this study was 1.6 times the dose noted by Schafer (1979). Our results support previous field studies (Woronecki et al. 1989, Drennan et al 1987) that indicated Shafer's (1979) published LD_{50} value was low. This difference may be from changes in purity or administration of the chemical, health of the test birds, timing of the test regarding physiological status of the birds, or environmental factors (e.g., fresh water).

In pens, AC-treated gulls died within 6 hours, whereas DRC-1339 treated gulls died 1.5–7 days after treatment. In field trials with both DRC-1339 and AC, treated gulls had time to disperse from the bait site, but all AC-affected birds were immobilized within 4 hours of treatment and picked up. Locating and removing DRC-1339 gulls required searching for a minimum of 4 days after treatment.

In our field trials, 69% of the consumed AC baits resulted in a captured gull (all within 4 hours) compared to 29% of the consumed DRC-1339 baits (gulls found dead 2–3 days later). The gulls that recovered after AC field treatments in the LD_{99} range may have regurgitated the bait away from the nest, eaten only part of a bait, or been unaffected by AC. Those birds that were not found after eating AC-treated bait were likely sedated but did not succumb on the island or on the water within our search area. All birds sedated at 30 mg/kg should have survived unless they drowned. Our search area was similar for both chemicals, but was limited and may have resulted in conservative estimates of affected birds.

AC acts rapidly as a brain and central nervous system depressant (Balis and Monroe 1964). The tremors we observed in AC-treated birds are common and do not harm the animal (Balis and Monroe 1964). There are no known lasting physiological effects for birds that consume nonlethal doses of AC (Balis and Monroe 1964, Lees 1972). Woronecki et al. (1990 and 1992) reported 18 translocations involving approximately 1,000 AC-captured waterfowl with no known long-lasting deleterious effects of AC on the birds. In contrast, DRC-1339 kills by slowly impairing the circulatory system, causing uremic poisoning and congestion of major organs.

At the dosages used, AC cost \$ 0.05–0.16/kg and DRC-1339 cost \$ 0.03/kg. Under current FDA registration restrictions, any AC used on gulls would be for capture only; therefore cost would be \$0.05/kg. AC should be more cost-effective than DRC-1339 in removing gulls because cost/bait is similar and less time would be required to locate birds with a greater percentage of baited birds being captured. Finally, if the desired population reduction was not achieved, further treatments with AC could be conducted within a day instead of having to wait up to a week to collect all affected birds as when using DRC-1339.

AC has been well received by the public when used to resolve nuisance waterfowl and pigeon problems (Woronecki and Dolbeer 1994). All captured gulls should recover from AC because the FDA label restricts AC to use for capture only. Therefore, all captured gulls could either be relocated or euthanized. Sedated but not captured gulls would recover within 24 hours. Registration of AC as a toxicant would require obtaining registration from EPA after completing all required tests. We conclude that AC, at a dose of 30 mg/kg, should be registered through FDA as a capture agent for gulls to serve as an alternative method to DRC-1339 for removing unwanted gulls from a population. Using AC at a greater dose as a toxicant to remove unwanted gulls is an option that should be explored.

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